

U.S. Patent Application Serial No. 09/504,923  
Amendment dated September 29, 2003  
Reply to OA of March 28, 2003

**AMENDMENTS TO THE CLAIMS:**

This listing of claims will replace all prior versions, and listings, of claims in the application.

**Listing of Claims:**

Claim 1 (Currently Amended): A process for producing a barrier film by a heat CVD method which comprises the steps of:

providing a substrate on a substrate holder in a vacuum atmosphere within a CVD apparatus;  
heating said substrate;

introducing a feedstock gas selected from tungsten hexafluoride gas and W(CO)<sub>6</sub> gas having a high temperature-melting point metal in its structure, [[and]] a reductive nitrogen-containing gas selected from among N<sub>2</sub>H<sub>4</sub> gas, NF<sub>3</sub> gas, N<sub>2</sub>O gas, and NH<sub>3</sub> gas, comprising a nitrogen atom a nitrogen free auxiliary reductive gas selected from among SiH<sub>4</sub> gas, H<sub>2</sub> gas, Si<sub>2</sub>H<sub>6</sub> gas, PH<sub>3</sub> gas, and B<sub>2</sub>H<sub>6</sub> gas into said vacuum atmosphere[[; and]] forming so as to form a film of the tungsten nitride of said high temperature-melting point metal on said substrate, wherein said step of forming said film of the nitride includes a plasma-free formation of said film;

wherein O<sub>2</sub> gas a nitrogen-free auxiliary reductive gas is introduced into said vacuum atmosphere.

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Claim 2 (Canceled)

3. (Currently Amended): A process for producing a barrier film by the heat CVD method comprising the steps of:

providing a substrate on a substrate holder in a vacuum atmosphere within a CVD apparatus;  
heating said substrate;  
introducing a feedstock gas selected from among tungsten hexafluoride gas and W(CO)<sub>6</sub> gas,  
having a high temperature-melting point metal in its structure a reductive nitrogen-containing gas  
selected from among N<sub>2</sub>H<sub>4</sub> gas, NF<sub>3</sub> gas, N<sub>2</sub>O gas, and NH<sub>3</sub> gas, a nitrogen free auxiliary reductive  
gas selected from among SiH<sub>4</sub> gas, H<sub>2</sub> gas, Si<sub>2</sub>H<sub>6</sub> gas, PH<sub>3</sub> gas and B<sub>2</sub>H<sub>6</sub> gas into said vacuum  
atmosphere[[; and]]

forming so as to form a film of the tungsten nitride of said high temperature-melting point  
metal on said substrate, wherein said step of forming said film of the nitride includes said tungsten  
nitride film is formed by a plasma-free formation of said film,

wherein O<sub>2</sub> gas is introduced into said vacuum atmosphere,  
wherein a nitrogen-free auxiliary reductive gas is introduced into said vacuum atmosphere;  
said nitrogen-free auxiliary reductive gas being introduced together with said feedstock gas into said  
vacuum atmosphere.

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Claim 4 (Currently Amended): The process for producing a barrier film by the heat CVD method according to claim [[2]]1, wherein, ~~in the step of introducing said auxiliary reductive gas together with said reductive nitrogen-containing gas and said feedstock gas~~, said reductive nitrogen-containing gas is introduced at a flow rate once or more higher than the flow rate of said feedstock gas, and said nitrogen free auxiliary reductive gas is introduced at a flow rate once or more but not more than 10 times higher than the flow rate of said reductive nitrogen-containing gas.

Claim 5 (Currently Amended): The process for producing a barrier film by the heat CVD method according to claim 1, wherein, ~~in the step of introducing said auxiliary reductive gas together with said reductive nitrogen-containing gas and said feedstock gas~~, said reductive nitrogen-containing gas is introduced at a flow rate once or more but not more than 5 times higher than the flow rate of said feedstock gas, and said nitrogen free auxiliary reductive gas is introduced at a flow rate 2 times or more but not more than 10 times higher than the flow rate of said reductive nitrogen-containing gas.

Claim 6 (Currently Amended): The process for producing a barrier film by the heat CVD method according to claim [[2]]1, wherein, ~~in the step of introducing said auxiliary reductive gas together with said reductive nitrogen-containing gas and said feedstock gas~~, said nitrogen free auxiliary reductive gas is introduced at a flow rate once or more but not more than 15 times higher than the flow rate of the feedstock gas ~~having said high temperature-melting point metal~~.

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Claim 7 (Currently Amended): The process for producing a barrier film by the heat CVD method according to claim 1, wherin, ~~in the step of growing the film of the nitride of said high temperature-melting point metal, a diluent gas not reacting with said high temperature-melting point metal and a gas having an oxygen atom in its chemical structure are introduced so that the pressure of said vacuum atmosphere is regulated to 1 Pa or more but not more than 100 Pa when said tungsten nitride film is formed.~~

Claim 8 (Currently Amended): The process for producing a barrier film by a heat CVD method according to claim 1, further comprising the steps of:

forming a barrier film made of a film of the ~~tungsten~~ nitride of a high temperature-melting point metal on a substrate on a substrate holder in a vacuum atmosphere within a CVD apparatus; exposing the surface of said substrate to a plasma of hydrogen gas and a plasma containing at least one gas selected from among argon, nitrogen and helium gases; and then forming the film of the ~~tungsten~~ nitride of said high temperature-melting point metal on the surface of the substrate, wherein the step of forming the film includes the step of heating the substrate.

Claim 9 (Withdrawn): A barrier film comprising a thin nitride film of a high temperature-melting point metal, wherein[  
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said thin nitride film has a content of said high temperature-melting point metal exceeding the stoichiometric composition ratio thereof.

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Claim 10 (Withdrawn): A barrier film comprising a thin nitride film of a high temperature-melting point metal formed on a substrate and aiming at preventing the diffusion of metals in an interconnecting thin film formed on said thin nitride film, wherein[;;]  
said thin nitride film is free from silicon.

Claim 11 (Currently Amended): A process for producing a barrier film which comprises the steps of:

providing a substrate on a substrate holder in a vacuum atmosphere within a CVD apparatus;  
heating said substrate;  
introducing a feedstock gas selected from tungsten hexafluoride gas and W(CO)<sub>6</sub> gas having a high temperature melting point metal in its structure, and a NH<sub>3</sub> gas, and a reductive gas selected from SiH<sub>4</sub> gas and Si<sub>2</sub>H<sub>6</sub> gas into said vacuum atmosphere[; and]] forming so as to form a film of the tungsten nitride of said high temperature-melting point metal on said substrate, wherein said step of forming said film of the nitride includes a plasma-free formation of said film, wherein a reductive Si-containing gas is introduced into said vacuum atmosphere.

Claim 12 (Cancelled)

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Claim 13 (Currently Amended): The process for producing a barrier film, comprising the steps of:

providing a substrate on a substrate holder in a vacuum atmosphere within a CVD apparatus;  
heating said substrate;

introducing a feedstock gas selected from tungsten hexafluoride gas and W(CO)<sub>6</sub> gas, and  
a NH<sub>3</sub> gas, and a reductive gas selected from SiH<sub>4</sub> gas and Si<sub>2</sub>H<sub>6</sub> gas having a high temperature-  
melting point metal in its structure into said vacuum atmosphere[[; and]]

forming so as to form a film of the tungsten nitride of said high temperature-melting point  
metal on said substrate, wherein said step of forming said film of the nitride includes said tungsten  
nitride film is formed by a plasma-free formation of said film,

~~wherein a reductive Si-containing gas is introduced into said vacuum atmosphere, said~~  
~~reductive Si-containing gas being introduced together with said feedstock gas into said vacuum~~  
~~atmosphere.~~

Claim 14 (Currently Amended): The process for producing a barrier film according to claim 12, wherein, ~~in the step of introducing said reductive Si-containing gas together with said NH<sub>3</sub> gas~~  
~~and said feedstock gas~~; said NH<sub>3</sub> gas is introduced at a flow rate once or more higher than the flow rate of said feedstock gas, and said reductive Si-containing gas is introduced at a flow rate once or more but not more than 10 times higher than the flow rate of said NH<sub>3</sub> gas.

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Claim 15 (Currently Amended): The process for producing a barrier film according to claim 11, wherein, ~~in the step of introducing said reductive Si-containing gas together with said NH<sub>3</sub> gas and said feedstock gas,~~

said NH<sub>3</sub> gas is introduced at a flow rate once or more but not more than 5 times higher than the flow rate of said feedstock gas, and said reductive Si-containing gas is introduced at a flow rate 2 times or more but not more than 10 times higher than the flow rate of said NH<sub>3</sub> gas.

Claim 16 (Currently Amended): The process for producing a barrier film according to claim 12, wherein, ~~in the step of introducing said reductive Si-containing gas together with said NH<sub>3</sub> gas and said feedstock gas,~~ said reductive Si-containing gas is introduced at a flow rate once or more but not more than 15 times higher than the flow rate of the feedstock gas ~~having said high temperature-melting point metal.~~

Claim 17 (Currently Amended): The process for producing a barrier film according to claim 11, wherein, ~~in the step of growing the film of the nitride of said high temperature-melting point metal, a diluent gas not reacting with said high temperature-melting point metal and a gas having an oxygen atom in its chemical structure are introduced so that the pressure of said vacuum atmosphere is regulated to 1 Pa or more but not more than 100 Pa when said tungsten nitride film is formed.~~